Permit Conditions
for
Tritium Bioassay and Effluent Monitoring

Background

Permit Holders requesting the use of milliCurie quantities of hydrogen-3 (tritium) must take special care to prevent the release of tritium to the environment and to prevent its accidental ingestion or inhalation.

This document describes the procedures that must be accomplished for obtaining a bioassay for tritium intake and for monitoring effluent releases.

In this Document

This document covers the following topics:

Continued on Next Page

Policy

A tritium bioassay is required:

If the operation is conducted in a ...	And the activity of volatile H-3 exceeds:
Open room or on a laboratory benchtop	100 mCi
Fume hood of adequate face velocity	1,000 mCi

An individual's urine must be evaluated for tritium content:

- **No earlier than 24 hours after the use, and**
- **No later than 72 hours after the use.**

Limits on Uptake

This table shows the limits on concentration of hydrogen-3 in urine.

Criteria	Limit
Weekly Limit for Whole Body Uptake	2×10^{-3} µCi / ml
Permit Holder Investigation Level	6×10^{-4} µCi / ml
Radiation Safety Staff Notification Level	2×10^{-4} µCi / ml

Effluent Limits to Unrestricted Areas

The concentration of hydrogen-3 released to unrestricted areas can not exceed an average of 1×10^{-7} µCi / ml.

This value can be averaged over a period of time that exceeds the actual time of the operation. It is RSS policy to limit the time to 8 hours. Additional time can be allowed upon approval of the RSS.

General Precautions

All procedures involving milliCurie quantities of tritium (where the tritium compound is or could become volatile) must be conducted in a properly operating chemical fume hood. This includes:

- Opening of packages;
- Dilution of stock solutions; and
- Chemical procedures.

Individuals handling tritium compounds shall wear a lab coat and protective gloves.

Continued on Next Page

Bioassay Collection Method	Each individual requiring a bioassay shall collect, handle, and count their own samples. This shall be done by collecting all of the urine in a single urination-void, withdrawing a 1-10 ml sample and discarding the remainder.
Effluent Air Collection Method	When sampling effluent air for hydrogen-3, the air sample should be passed through a cold trap (such as acetone/dry ice) to remove the water vapor from the air stream. This assumes that the tritium is in the form of tritiated water. If a different chemical compound is known to be released, special chemical or physical filters must be used.
Sample Preparation	No specific sample preparation is required. Low potassium glass or plastic vials should be used to minimize background counts. The sample vials should be allowed to dark adapt in the scintillation counter for one hour prior to counting to minimize fluorescence. The RSS must review and approve each sample preparation and analysis procedure used for tritium bioassay.
Instrument Calibration	Portable survey instruments are inappropriate for monitoring the weak beta particle emitted by hydrogen-3. A liquid scintillation counter is adequate for counting contamination wipes and bioassay samples. This counter should be calibrated on an annual basis using National Institute of Standards and Technology (NIST) traceable standards.
Formula for Determining Concentration	The concentration of tritium in the sample in units of µCi / ml can be calculated using the following formula: $$\text{Concentration} = [\ C_s - C_b\ ] / [\ (\ 2.22 \times 10^6\ )\ E\ V\ ]$$ where: C_s = Gross sample counts per minute C_b = Background counts per minute E = Counting efficiency for tritium V = Volume of sample 2.22×10^6 = DPM per µCi

Continued on Next Page

Formula for Determining Minimum Detectable Activity

The minimum detectable activity for the counter in units of µCi / ml can be calculated using the following formula:

$$MDA = \{[\ 2.71 / T\ ] + 4.65(R_b\ T)^{1/2}\} / [\ (\ 2.22x10^6\ )\ E\ V\ ]$$

where:

R_b	= Background count rate
T	= Counting time
E	= Counting efficiency for tritium
V	= Volume of sample
$2.22x10^6$	= DPM per µCi

The calculated MDA must be lower than the limits on uptake or the effluent limits or the counting procedure is not valid.

Additional information on calculating minimum detectable activity can be found in the Radiation Safety Staff's Technical Bulletin titled "Determining Lower Limit of Detection (LLD) and Minimum Detectable Activity (MDA) for Radiation Measurements".

Records Retention

The following worksheet is used in this program:

- Tritium Bioassay Worksheet (RSS-40)

This worksheet must be retained by the facility LRPO for three years. Copies must be submitted to the RSS for review.

Using Program Forms and Worksheets

The forms and worksheets used with this document provide the basis for an individual to document the surveys and assessments performed.

All of the worksheets describe the policy that must be met for radiation safety surveys and include the minimum amount of information needed to provide traceability and repeatability of the measurements, if needed.

The procedures section assures that the proper calculations have been performed.

Upon receipt of the forms by the RSS, the calculations are entered into a spreadsheet to verify the calculations.

Continued on Next Page

Questions If there are any questions regarding the information in this document, contact:

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